Brack *et al. Environ Sci Eur* (2019) 31:47
https://doi.org/10.1186/s12302-019-0228-7

Environmental Sciences Europe

EDITORIAL **Open Access**

Let us empower the WFD to prevent risks of chemical pollution in European rivers and lakes

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Recently, the Guardian published an article entitled "EU clean water laws under attack from industry lobbyists" by Arthur Neslen (https://www.theguardian.com/environment/2019/may/15/eu-clean-water-laws-under-attack-from-industry-lobbyists) expressing concerns regarding a roll back in European clean water regulations. As principal investigators of the large EU-funded project "SOLUTIONS for present and future emerging pollutants in land and water resources management", we appreciate such an open debate on water quality protection in Europe, which we would like to enrich with conclusions from 5 years of extensive research and stakeholder dialogue within SOLUTIONS and other large EU projects.

The European Water Framework Directive (WFD) is a unique piece of legislation dealing with the protection, monitoring and management of water quality which aims at achieving a good water status all over Europe by 2027. We appreciate this ambition, which we consider to be a milestone towards the well-being of European people and the protection of biodiversity and ecosystem functioning as well as an important step towards sustainable development in a non-toxic environment as projected by the European Commission.

Despite this ambition, the progress in achieving good ecological and chemical status according to the WFD appears to be limited. Good chemical status has not been achieved in most European river basins (in Germany, Sweden and some others there is 100% failure) due to ubiquitously occurring priority substances [1]. The number of water bodies classified as achieving good chemical status has not increased substantially since the WFD came into force in the year 2000. This poor quality status was confirmed by a plethora of scientific findings indicating chemical pollution in European rivers, associated toxic risks to aquatic ecosystems and significant impacts on the ecological quality status. There is clear evidence that European water bodies are polluted with complex mixtures of chemicals including pesticides, biocides, pharmaceuticals and industrial chemicals [2]. This "chemical cocktail" adversely affects aquatic organisms and the ecological status of European water bodies [3, 4]. Moreover, concurrence of pollution with other stress factors like climate and land use change or water scarcity worsens the situation. These findings also suggest that the chain of current WFD protection, monitoring, assessment and management needs to be improved. Strategies are required for identifying and abating those chemicals, mixtures and other factors driving the impacts on ecological quality. Incentives for investing in efficient pollution protection and management measures to reduce risks are needed even if not all WFD criteria for a good status can be reached.

A debate about options for improvements to the WFD, including the current fitness check of EU water laws, is therefore timely and supported by SOLUTIONS scientists. This debate, however, should not solely focus on the "one-out-all-out" principle in defining good status

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according to the WFD. It also needs to recognize that large numbers of chemicals from agriculture [5], industry [6, 7], households [8] and other sources are emitted in substantial quantities into European water resources, resulting in considerable impact [4, 9]. These emerge from both individual chemicals and, more importantly, from complex mixtures [10] compromising aquatic ecosystems and ecosystem services [11]. These mixtures and their associated risks are so far ignored by a chemical status that the WFD currently defines based on only 45 so-called priority substances, a miniscule fraction of more than 100,000 chemicals in commerce. Thus, on one hand, chemical status assessments currently underestimate toxic risks of mixtures substantially, and overlook hazardous chemicals that drive risks [12, 13]. This ignorance obscures the establishment of causal links between chemical and ecological status. On the other hand, the "one-out-all-out" principle [14] means that successful abatement which substantially reduces risks from new and emerging pollutants often remains unrewarded as long as individual legacy pollutants, defined as WFD priority substances, for which no management option is available, (e.g., mercury), exceed environmental quality standards. This situation prevents many possible improvements to the WFD chemical status.

SOLUTIONS suggests that this dilemma can only be solved by complementing the existing status assessments with more holistic protection from and monitoring, assessment and abatement of chemical pollution to address all chemicals that pose a risk, not just a handful of selected priority pollutants. It also requires assessing mixture effects and considering abatement options already at an early stage of the assessment. More differentiated assessments based on effects and risks of the entire mixture are suggested to create incentives for abatement even if the good status as it is defined currently is not achieved. This recommendation can be put into practice by implementing a set of efficient tools that have been developed and rigorously evaluated in large case studies within the 5 years of research in SOLUTIONS and other EU projects. These integrated tools include effect-based and chemical screening-based monitoring and assessment via whole mixture [15, 16] and component-based mixture assessment tools [17, 18], modelling tools to bridge data gaps, to assess continental scale risks and to assess future pollution scenarios [19, 20], and concepts to analyse the impact of chemical mixtures on the ecological quality [21]. Moreover, integrated approaches to estimate and prioritize chemical footprints of polluters can be considered with the aim to strengthen the "polluter pays" principle and to select abatement options [22]. These tools are fit for purpose and should be integrated in an updated WFD implementation strategy. They will substantially improve impact assessment and diagnosis and thus allow for the implementation of targeted and cost-effective abatement. At the same time, these tools will demonstrate improvement in water quality by successful mitigation measures (e.g., the upgrade of WWTPs in Switzerland [23, 24]) and increase the motivation for investments in water quality improvement and risk reduction. A series of policy briefs to be published in this Environmental Sciences Europe will provide further details.

To summarize, we should be aware that weakening the WFD as a legal instrument to protect European water resources may have severe impact on ecosystem services, biodiversity, on human well-being and sustainable development in Europe. Instead, the WFD deserves to be empowered to actually achieve its goals of protecting and establishing good water quality in European surface waters. The required concepts and tools to support this process are available.

Acknowledgements
The entire SOLUTIONS consortium is acknowledged for the excellent collaboration and fruitful discussions that prepared the ground for this editorial.
SOLUTIONS: https://www.solutions-project.eu/.

Authors' contributions
WB conceptualised and drafted the manuscript. SA, RA, IC, VD, BE, AF, AG, DH, KH, JH, HH, AK, MLdA, LP, ES, HS, JS helped to elaborate the text and contributed specific issues. All authors read and approved the final manuscript.

Funding
This article has been prepared as an outcome of the SOLUTIONS project (European Union's Seventh Framework Programme for research, technological development and demonstration under Grant Agreement No. 603437).

Availability of data and materials
Not applicable.

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 1 July 2019 Accepted: 1 July 2019
Published online: 07 August 2019

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